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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE



Federal Building,
Asheville, N. C.
May 10, 1932.

Director,
Great Basin Experiment Sta.,
Ogden, Utah.

Dear Sir:

We take pleasure in sending you herewith the ELEVENTH ANNUAL REPORT AND PROGRAM of the Appalachian Forest Experiment Station, presenting a summary of results obtained by the Station during 1931 and plans for the ensuing year.

The past work of the Station is bearing fruit, and each year sees a larger output of results. One purpose of the Annual Report is to indicate the nature of these results and the disposition made of them so that they may be more generally available. The major results are summarized on the introductory pages c-g and a list of articles prepared or published appears on pages 39-41. The projects and plans are discussed on the intervening pages.

Your comments and suggestions concerning this report are solicited and will be gratefully received.

Very truly yours,

E. H. Brothingham

Director.

Enclosure.

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ELEVENTH ANNUAL REPORT AND PROGRAM

APPALACHIAN FOREST EXPERIMENT STATION

Report for Calendar Year 1931

Program for Fiscal Year Beginning July 1, 1932

CONTENTS

	<u>Page</u>
Personnel of the station.....	a
Appalachian forest research council: 1932.....	b
Summary of accomplishments during the past year.....	c
Territory of the station.....	1
The reason for forest research in the southern appalachinas.....	1
Investigative projects.....	2
Forest Management.....	2
Management: mountain hardwood forests.....	2
Management: coastal pine forest.....	7
Protection: fire damage.....	10
Mensuration: mountain hardwood forest.....	15
Planting.....	16
Botanical studies: phenology.....	17
Forest influences.....	18
Streamflow and erosion.....	18
Forest economics.....	21
Extensive revision.....	21
Biological investigations.....	22
Forest pathological investigations.....	24
Forest entomology.....	26
Experimental forests.....	31
Natural areas.....	32
All-Service projects.....	32
Finances.....	33
Meetings.....	33
Personnel changes.....	35
Investigative needs.....	35
Summary of forest service projects, and assignment of personnel.....	38
Articles prepared or published.....	39
Articles to be prepared in fiscal year 1933.....	41

APPALACHIAN FOREST EXPERIMENT STATION

PERSONNEL, 1931

E. H. Frothingham	Director
C. R. Hursh	Forest Ecologist
R. M. Nelson (Appointed Aug. 15, 1931)	Silviculturist
L. I. Barrett	Associate Silviculturist
J. H. Buell	Assistant Silviculturist
I. H. Sims	Assistant Silviculturist
A. L. MacKinney	Assistant Silviculturist
C. A. Abell	Junior Forester
Margaret S. Abell	Junior Forester
E. M. Manchester (Appointed Aug. 1, 1931)	Ranger
Josephine Laxton	Senior Clerk
Elisa M. Pearson	Clerk
Lillian B. King	Senior Stenographer
Mary P. Gudger (Appointed Aug. 3, 1931)	Junior Stenographer

BUREAU OF ENTOMOLOGY

R. A. St. George	Associate Entomologist
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BUREAU OF PLANT INDUSTRY

R. M. Nelson (Resigned Aug. 14, 1931)	Assistant Pathologist
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BIOLOGICAL SURVEY

T. D. Burleigh	Associate Biologist
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TEMPORARY ASSISTANTS, 1931

Forestry

John C. Baker	Indiana	J. T. Kimberley	Connecticut
R. K. Daley	Connecticut	H. J. Longhead	Pennsylvania
C. W. Genth	Massachusetts	H. J. Pawek	Minnesota
V. E. Hicks	Illinois	L. E. Peterson	Minnesota

Biology

W. J. Jackson	North Carolina
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Entomology

Ralph Caird	Illinois	L. E. Peterson	Minnesota
Barnard Huckenpahler	Minnesota	Noel Wygant	

Pathology

C. E. Phelps	Pennsylvania
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APPALACHIAN FOREST RESEARCH COUNCIL

MEMBERSHIP IN 1932

W. D. Tyler,	President
J. H. Pratt, Chairman of Executive Committee	
E. H. Frothingham,	Secretary

Georgia

T. G. Woolford, Retail Credit Company, Atlanta.

Kentucky

T. P. Cooper, Director, Kentucky Agr. Experiment Station, Lexington.
W. J. Hutchins, President, Berea College, Berea.

North Carolina

G. A. Cardwell, Atlantic Coast Line Railway, Wilmington.
Andrew Gennett, President, Gennett Lumber Company, Asheville.
J. S. Holmes, State Forester, Raleigh.
J. H. Pratt, Consulting Engineer, Chapel Hill.
Verne Rhoades, Consulting Forester, Asheville.
R. B. Robertson, President, Champion Fibre Company, Canton.

South Carolina

H. A. Smith, State Forester, Columbia.
H. L. Tilghman, Tilghman Lumber Company, Marion.

Tennessee

J. C. Hazard, State Forester, Nashville.
S. F. Horn, Editor, Southern Lumberman, Nashville.

Virginia

J. A. Burruss, President, Va. Polytechnic Institute, Blacksburg.
P. R. Camp, Camp Manufacturing Company, Franklin.
J. P. Hummel, President, Hummel-Ross Fibre Corporation, Hopewell.
Chapin Jones, State Forester, Charlottesville.
W. D. Tyler, Vice President, Clinchfield Coal Corporation, Dante.

West Virginia

T. H. Claggett, Chief Engineer, Pocahontas Coal and Coke Co., Bluefield.
John Raine, President, Meadow River Lumber Company, Rainelle.
B. L. Roberts, Cherry River Boom and Lumber Company, Richwood.

SUMMARY OF ACCOMPLISHMENTS DURING THE PAST YEAR

Forest Management

Management: mountain hardwood forests

1. A year of work in north Georgia resulted in the first systematic compilation of information on the extent, composition, and productive value of the forests of that region, and their relation to watershed protection and recreation. These results have been summarized as Bulletin 15 of the Georgia Forest Service entitled "Forests of the Georgia Highlands." It points out for the owner of mountain woodlands in north Georgia the rate of timber growth that can be expected on his holdings under natural conditions, and how this growth may be increased by improvement cuttings and thinnings.

2. Results of seven years' study of the progress of yellow poplar reproduction on burned and unburned clear-cut areas at Bent Creek have been compiled. Although during the year following the treatment seedlings of this valuable timber tree germinated on the burned areas at the rate of some 30,000 per acre and on the unburned at the rate of some 2,000 per acre, they have almost without exception disappeared in the subsequent seven years. The conclusion reached in an article entitled "Establishment and Survival of Yellow Poplar Following a Clear Cutting in the Southern Appalachians," which describes the study, is that root competition and shade are probably the primary causes of failure.

3. Forty acres on the Bent Creek forest were cut over experimentally, and twenty additional acres were marked for cutting during 1931. Seven different methods of cutting are being tried as part of a series designed to find the ones most suitable to reproduce the forest and improve its rate of growth.

4. A preliminary analysis of data from the cut-over land survey of 1927, 1928, and 1929 was made for inclusion in U. S. D. A. Technical Bulletin 250. This analysis shows that as a result of logging without reference to future production the average cut-over stand in this region is only about half stocked with trees over 3 inches in breast high diameter, of which 70 to 80 per cent are of poor form or of less desirable species. The survey also revealed an unpromising condition of the reproduction which has followed cutting. More than half of it will be hindered in its growth by overhead shade, and much of it is of less desirable species. These results point directly to the need for improving over-cut and run-down forest lands to restore their productivity.

5. A study of methods and costs of releasing white pine reproduction under an overstory of defective hardwoods was begun on the Cherokee National Forest near Blairsville, Ga. White pine is a promising species in this region because of its rapid growth and wide usefulness, but its

reproduction often comes in under an overstory which will hinder it. In this study removal of the overstory by girdling and by poisoning will be tried.

6. A tool for poisoning trees was improved, manufactured, and tested out on some plots at Blairsville, Ga., where old, defective hardwoods were to be killed. The tool is based on one originally described by J. A. Cope and J. N. Spaeth in the Journal of Forestry, May, 1931, but it embodies several modifications. The use of the tool in the work in Georgia showed that it was faster than axe girdling, but the test can hardly be considered complete since only about 150 trees were treated and the workmen were not used to the instrument. Several improvements were suggested by this tryout. A paper describing the tool has been prepared for publication in the Forest Worker.

7. A study of the growth of trees left after a cutting to a diameter limit of 12 inches in a well-stocked hardwood stand typical of many small holdings in north Georgia was made during the year. This study will serve incidentally as the basis for a working plan for the Georgia Mountain Experiment Station Forest where it was conducted, but its results will be of wider use to the owners of mountain woodlands by showing them what can be expected to happen to the residual stand following a cutting for lumber and ties. This work properly falls under the subject of forest mensuration, but since funds for work in this subject are not available such growth studies as are indispensable to other lines of work are being carried by the allotment for forest management.

Management: coastal pine forests

8. The data from the study of logging and milling costs conducted in 1929 by the Forest Products Laboratory and the Appalachian Forest Experiment Station on the lands of the Camp Manufacturing Company at Franklin, Va., were analyzed during the year and presented in Bulletin 43 of the Virginia State Forest Service. This analysis showed that a large, stationary mill could not profitably cut and manufacture trees less than 13 inches in diameter, breast high. Preliminary compilations of the data from a similar study at Windsor, N. C., showed, however, that a small, portable band mill can profitably handle trees as small as 11 inches diameter, breast high.

9. The preliminary results of a study of poisoning, felling, and girdling as a means of disposing of undesirable hardwood trees interfering with loblolly pine reproduction was prepared for publication during 1931 and appeared in the Journal of Forestry of February, 1932. The conclusion of this preliminary study is that poisoning with sodium arsenite solution introduced into axe cuts is cheaper and more effective than girdling or felling.

10. An analysis was made in 1930 of the data on increased growth of loblolly pine trees left after cutting. The indications are that pines completely liberated by the removal of all trees within 30 feet of them grow as fast after liberation as trees of the same class which have never been subjected to competition, and that there is a tendency for released trees to grow more rapidly in diameter at points high on the bole than at breast height, which is the usual point of diameter measurement.

11. In 1931 four 2-acre sample plots were established near Charleston, S. C., in connection with a third study of logging and milling costs conducted by the Forest Products Laboratory. These plots will show the results of various degrees of severity of cutting.

Protection: mountain hardwood forest

12. From data on forest fire wounds at the bases of various species of trees, a correlation was found between area of charred bark and area of wound or killed cambium. Differences in the ratio of wound to external discoloration were found between species and size classes of trees studied. The purpose of this work is to measure specific differences between species in susceptibility to fire damage, and to devise a practical field means for judging the severity of injury. A simplified field method was developed for estimating the area of external discoloration and of wound which will enable a reasonably close estimate of basal injury by fire damage appraisers. The fact that the ratio between wound and charred bark area differs between species indicates that marked differences are to be expected in susceptibility to fire injury.

13. Equipment and methods were devised for comparing the resistance to the heat of forest fires afforded by different barks at different seasons. The equipment and methods are to be used in a further study of the resistance of species to basal fire damage. A knowledge of differences in the relative susceptibility of different tree species to injury by fire is one of the factors which must be taken into account in forest management, in working for stands of timber which will be most suitable for locations subject to the risk of forest fires.

Protection: coastal pine forest

14. Compilation of measurements taken on a burned and unburned plot in the longleaf pine type near Summerville, S. C., showed that annual burning retards the growth of young pines. In 13 years, during which one plot was burned over annually and the other never, the trees on the unburned plot grew 19 per cent faster in height, 9 per cent faster in diameter, and 22 per cent faster in volume.

Forest Influences

Streamflow and erosion

15. As an outcome of preliminary studies it has been found that the most important single factor governing streamflow and erosion in the southern mountains is the nature and condition of the organic layers of the soil. This factor, in turn, is controlled largely by the characteristic vegetative cover, its composition and history. The future studies on the project will therefore center largely around the organic layers of the soil as they are related to the vegetative cover.

16. A limited number of experimental installations have been made to develop methods and instrumentation for studying the above-mentioned relationship between the vegetative cover and the organic layers of the soil as affecting water economy of small unit areas. In this same connection the project leader visited a number of field installations elsewhere where streamflow, erosion, and vegetative cover relationships are being studied.

Forest Economics

Extensive Revision

17. As part of a country-wide project, forest statistics were compiled by the Station for the States of West Virginia, Virginia, North Carolina, and South Carolina. The data, compiled from the best existing sources, included information on forest land areas by forest types, age, and condition classes; stand of sawtimber and cordwood, of each important species; the rate of growth in each major forest type, and the rate of depletion due to cutting, fire, insects, diseases, and other causes. But the figures are to a large extent speculative, and the need for a forest survey to supply fully authoritative data on all of the above-named items has been emphasized by this work more than ever before.

Biological Investigations

18. An attempt has been made to reintroduce the beaver, long since exterminated in the Southern Appalachians. Four beavers were liberated at two points near Asheville. Success in this undertaking will mean not only adding a valuable source of fur to this part of the State, but also aiding to no small extent the control of streamflow in this rough mountainous country.

19. A study of the effect of forest fires upon the wild life of the mountain forests has been initiated. Sample quarter-acre plots, representing recently burned and unburned areas in the various forest types of the neighborhood of Asheville, were established, on which trapping operations are in progress to determine the relation of fire to the population of rodents and other small mammals. Stomach contents of the mammals caught are being examined to throw light on the food habits on burned areas. This study was started recently and while surprisingly large numbers of mice have been captured on the freshly burned areas, the data are not yet in form to yield conclusive results.

Forest Pathological Investigations

Chestnut blight

20. Results of an experiment to find out whether the removal of all except the most vigorous chestnut sprout from sprout clumps of chestnut would result in materially increasing the growth rate of the single sprout left were compiled. It is shown that this treatment did not materially increase the growth rate of the sprouts left, and that because of the rapidity of infection of sprouts by the blight such treatment is not suitable for the production of tannin extract wood.

Experiments with bluestain fungi in living pines

21. As the result of experiments continued over a number of years it has been found that there is an association of a specific bluestain organism with a specific bark beetle. Pines attacked by the southern pine beetle invariably become bluestained before death, which occurs within a few weeks after attack. The bluestain fungi grow chiefly in the ray parenchyma cells and resin ducts. Stained sectors in sapwood block the upward flow of the transpiration current, reducing the water content of the bole and producing the condition which is apparently necessary for proper beetle brood development. Tunnels made by bark beetles are sufficient to kill pines in time, but the immediate cause of death is the action of the associated bluestain fungi.

Decay in loblolly pine on the coastal plain

22. Examinations conducted in connection with the selective logging study at Franklin, Va., and compiled for publication in Bulletin 43 of the Virginia State Forest Service, show that 11 per cent of the trees were infected with red heart caused by Trametes pini. The percentage of trees infected increased from 5 in the 40-90 year age class to 19, 60, and 72, respectively, in the 90-140, 140-190, and 190-230 year age classes. The only invariable outward sign of the decay was the presence of sporophores of this fungus and the length of infected bole on the 15 trees that bore sporophores averaged 50 feet. Data from a similar study in South Carolina have been collected but not yet analyzed.

ELEVENTH ANNUAL REPORT (1931) AND PROGRAM (FISCAL YEAR 1933)

APPALACHIAN FOREST EXPERIMENT STATION

TERRITORY OF THE STATION

The Appalachian Forest Experiment Station is one of eleven stations maintained by the United States Forest Service to study forest conditions and problems in the different forest regions of the United States. The Appalachian Station was established July 1, 1921, with headquarters at Asheville, N. C. Its territory comprises three major physiographic regions: the Appalachian and Cumberland Mountains from West Virginia to Georgia; the plateau regions on both sides of the mountains; and the Atlantic coastal plain of North and South Carolina and Virginia. The Station's work has so far been confined to the predominantly hardwood forest of the mountains and the loblolly pine forest of the coastal plain. Investigations have not yet been authorized for the plateau forest, which is made up chiefly of small woodlands on farms, nor for the extensive hardwood bottomlands of the coastal plain.

THE REASON FOR FOREST RESEARCH IN THE

SOUTHERN APPALACHIAN REGION

The problems now being studied by the Station have to do with the best management of timberlands for highest permanent returns. The original condition of these timberlands has been greatly modified by long continued lumbering and fire which have left a considerable part depleted and relatively unproductive. This condition has been accentuated by other destructive agencies such as the chestnut blight, the southern pine beetle, drought, ice, and wind. A smaller part, thanks to the native vigor of the forest, has become restocked, in spite of mismanagement, with more or less thrifty stands of second-growth. There still remain scattered vestiges of the virgin forest, amounting to 5 or 10 per cent of its original extent. Thus conditions which must be taken into account in the Station's investigations are exceedingly complicated, the more so because of the large number of tree species native to the region, which occur in many different combinations, or "forest types."

The Station's work is concerned with land use questions which are largely an aftermath of logging. As long as quantities of virgin timber remained to be harvested in the Southern Appalachians, the value of the forest was chiefly that of the timber itself; the land was of little consequence unless it had agricultural promise. Now, however, with the remaining virgin timber reduced to only 5 or 10 per cent of its original extent, a shift of emphasis is taking place from the value of the timber itself to that of the land which produced it and which is capable of producing successive timber crops in the future. As evidence of this shift,

every one of the seven states that fall wholly or partly within the Station's territory now maintains a forest organization, while four of the states also employ specialists in farm forestry; there are seven national forests under administration in the region; and a number of private timber-holding organizations employ foresters or make use of forestry advice for the protection or management of timberlands. Other uses than timber production are coming into the picture; there is a growing recognition that timberlands also have an intimate relation to soil erosion, the regulation of streamflow, and the maintenance of game and fur-bearing animals.

The function of the Appalachian Station is therefore to furnish reliable information for the development of many classes of forest to meet all uses. Its investigations, with those of its co-operating agencies, are directed along lines corresponding to these uses, under the major designations of forest management, forest protection, planting, forest measurement, botanical studies, erosion and streamflow investigations, biological studies, and investigations of injurious forest insects and tree diseases. The work on these various projects and the plans for the coming year are summarized in the following pages.

INVESTIGATIVE PROJECTS

FOREST MANAGEMENT

Management - Mountain Hardwood Forest

The general purpose of this project is to find practicable methods for increasing the productivity of existing forests. In the mountain region most of the timberland area has been cut over, some of it four or five times, and large parts of it have been severely burned. Logging generally removed only the merchantable timber and left many poor, defective trees to interfere with the oncoming second-growth. The latter has suffered a great deal from fire, which in many cases has increased the proportion of poor tree species and shrubs, or has changed a promising seedling reproduction into one of sprouts. Chestnut, formerly the most abundant of the mountain timber species, is rapidly being killed by the blight, and its loss will mean a profound change in the forest composition. In short, the mountain timberlands over hundreds of thousands of acres have reached a low ebb, and it is the purpose of this project to find the means for ensuring the best development of the succeeding stands.

This project brings together under one head related studies formerly pursued as separate projects, and treated in previous annual reports of the Station as Mc-2, the improvement of mountain forest by better methods of cutting; M-3, the natural replacement of blight-killed chestnut; Mt-2, methods of thinning in mountain hardwoods; and Mt-1, thinnings in the Biltmore plantations. In addition, two other projects, M-1 and M-2, covered the details of managing the Bent Creek experimental forest and of carrying on investigations in forest management in North Georgia. These

were actually administrative rather than investigative projects.

An analysis of the subjects formerly covered by the above project shows that they fall logically into three classes. The object of the first is to find methods of logging mountain hardwood stands so that an abundant reproduction may be obtained to keep the land productive. The second class deals with cultural methods which will improve the composition and rate of growth of the new stand resulting from harvest cuttings by eliminating poor species and favoring the more valuable trees. The third class is more fundamentally scientific in nature. It proposes to discover the reasons for the success or failure of desirable reproduction. Its results will tend to corroborate those of the first two classes and to remove much of the uncertainty that goes with trial and error experimentation.

Past Work

As a first step in learning proper methods of harvesting forest crops it was desirable to find out as much as possible about the results from the cuttings already made in the mountain forests. An extensive survey of cut-over areas was begun in 1915 and 1916. An unpublished report was prepared at that time. In 1922 and 1926 more field work was done, but the majority of the work was accomplished during the summers of 1927, 1928, and 1929. During that time seventeen areas were selected which had not been burned since the last cutting and for which some information was at hand as to the history of cutting. The majority of these areas were on national forests. About 335 sample plots - temporary plots mostly one-half acre in size - were tallied on cut-over areas in North Carolina, Virginia, West Virginia, and Kentucky.

The results of the recent work have been compiled by different forest types, conditions, and ages of cut-over areas. The complete analysis, is expected to form the basis for a report on the condition of unburned cut-over areas. The preliminary compilation of these data, made for the bulletin "Timber Growing and Logging Practice in the Southern Appalachian Region," indicates that the average cut-over stands are only about half stocked with trees over three inches in breast high diameter. Of these, 70 or 80 per cent, on the average, are crooked, unsound, or of relatively less desirable species. The figures bring out further that the reproduction on these areas is not particularly promising. The number of saplings that are unshaded and free to grow into trees is less than the number of shaded saplings; and of those free from shade less than half, as a rule, are of desirable species.

The past histories of areas already cut over are always uncertain. There is always a question as to just how the cutting was made. To control the methods used and watch the results following cuttings, permanent sample plots which are remeasured periodically have been established. The first of these were put in at Berea, Kentucky, on the Berea College forest, in 1923 and 1924, where a heavy cutting was made in cove hardwoods. A splendid reproduction resulted and it has been under close observation since

the cutting. Other plots have been established at North Mountain, Virginia, where cuttings were made in chestnut oak and cove hardwood types.

During 1930 five areas, aggregating 40 acres, on the Bent Creek Forest were cruised and marked for different sorts of cutting. Five 1/2 acre sample plots were laid out in them, and a sixth in a control area to be left uncut. Periodic remeasurements following the cutting, especially on the sample plots, will determine the extent to which the cuttings are successful in accomplishing the purpose for which they were intended. The cutting was done early in 1931, and is described under the heading "Results of the past year."

Since chestnut forms about a quarter of all the timber in the mountain forests, the chestnut blight, apparently fatal wherever it attacks, is one of the most destructive agencies that has ever entered the mountain region. Its depredations have been made the subject of a special study. Since it has long since been realized that it will be impossible to save the great bulk of the chestnut, attention is being centered on the results that will follow its work. Permanent sample plots similar to those already described have been established on the Shenandoah and Natural Bridge National Forests and at Bent Creek. Here the natural replacement of chestnut by other species will be carefully followed where the trees are allowed to die from blight attack and where the trees are felled. At Bent Creek a large number of small plots have also been established, each surrounding a chestnut stump. Here it is proposed to learn the effect on other reproduction of the large clumps of chestnut sprouts that originate from the cut trees.

Studies of cultural operations in growing stands may be divided into two heads. The first includes treatments to encourage young reproduction already established; the second is concerned with the thinning of even-aged second-growth. At Lookingglass Rock on the Pisgah National Forest some experiments in a dense stand of reproduction which followed a severe spring fire on a cut-over area, have been begun. Here young yellow poplar was in danger of being crowded out by a dense cover of young black locust, sumac, silver-bell, and chestnut. On one plot the undesirable species were cut, while the other plot was given no treatment. At McFalls Creek on the Natural Bridge National Forest 7 plots, comprising 4 experiments, were started in 1929. These plots were burned over in April, 1930, and their effectiveness for their original purpose was destroyed, but the maps and records previously prepared made them serviceable for the study of fire damage. Early results in both these experiments are described in U. S. Department of Agriculture Technical Bulletin 250.

The first thinning work undertaken by the Station was begun in 1916 on the Biltmore Estate where thinnings were made in plantations of white pine, shortleaf pine, and sugar maple. These plots have been thinned three times and the result of this work was discussed in the

Station's report for 1929. The plots themselves, and the plantations in which they are established, are discussed in U. S. Department of Agriculture Miscellaneous Publication 61, "Forest Plantations at Biltmore, N. C." At North Mountain, Virginia, and at Blairsville, Georgia, thinnings are being studied in mixed oak stands. At Cranberry, N. C., a group of plots to compare different methods of thinnings in a 40-year-old stand of yellow poplar were established in 1924. Three different methods of thinning were used: a "selection" thinning, which removed the largest and best trees, leaving the smaller to develop; a "crown" thinning, in which trees were removed that were interfering with especially good trees chosen as crop trees to be brought through to the end of the rotation; and a "low" thinning, in which the smaller trees in the stand were cut, leaving the dominant trees with a little added space for later development.

To date the Station has done little work of the fundamental character outlined above as the third class of work. In 1925 two plots were established in connection with a study of yellow poplar. A part of the area was clear cut and left unburned; another part was both cut and burned so that the effect of cutting and burning on the establishment of reproduction could be observed. During the past year a study has been started in Georgia to find the treatments necessary to insure the success of Virginia pine reproduction seeded in thickly on heavily cut-over hardwood land.

Results of the past year

Early in 1931 five areas in the Bent Creek experimental forest, near Asheville, were cut over in different ways. An area of six acres was clear cut, all brush and tree reproduction first being removed. The purpose of this is to learn what sort of reproduction will develop after an entirely clear cutting, as contrasted with the partial cuttings that were carried out on the other areas. On one of the latter (eleven acres) all trees of undesirable species, form, or condition, were removed. A third unit (nine acres) simulates ordinary commercial practice; all merchantable trees were cut. A fourth unit which includes a second-growth stand of yellow poplar, was cut to encourage the extension of the yellow poplar, by natural seeding, into the area immediately below the poplar stand. On a fifth area the cutting was designed to increase the proportion of chestnut oak in the stand. These various areas aggregate about 40 acres, and about 900 cords of wood were removed, most of it by the Asheville Community Woodyard Committee for unemployment relief. During the fall two additional units were cruised and marked for cutting and sample plots in them laid out. One unit of 18 acres is a mixture of pine and oak. It is the intention here to convert the stand into pine standards over hardwood coppice. At present the stand is very irregular. All of the over-mature and defective hardwoods will be cut and besides the pine standards and pine reproduction only the best of the other species will be left. The other unit of 2 acres is at present occupied with a stand of over-mature red maple, and a few thrifty yellow poplar seed trees. Everything will be cut except the yellow poplar to find out if such treatment will result in a new stand of that species. Four sample plots were established in these two latter units, similar to those already laid out in the areas cut over.

A study of release of white pine reproduction under an over story of defective hardwoods was begun on the Cherokee National Forest near Blairsville, Georgia. White pine is one of the most promising species for this section of the Station's territory. It is rapid growing and is valuable for pulp in small sizes as well as for lumber when it is full grown. In order to study the effect of such a cutting and its cost, three 1/4 acre sample plots were laid out and on one half of that area the overstory trees three inches and larger d.b.h. were girdled, while on the other half the same sizes were poisoned with a poisoning tool. Two 1/4 acre plots were left untreated as a control.

A tool for poisoning trees was improved, manufactured, and tested out on the plots at Blairsville, Georgia, described above. The tool is based on one originally described by J. A. Cope and J. N. Spaeth in the Journal of Forestry, May 1931, but it embodies several modifications. A paper describing this improved tool has been prepared.

A growth study was made on the 177 acre woodland of the Georgia Mountain Experiment Station. Besides contributing to the general data on growth of Southern Appalachian trees, this served as a basis for a working plan now in operation by the Georgia Experiment Station. The systematic operations on this forest will give an opportunity for an intensive study of growth on permanent plots established in the different cuttings.

In an article entitled "Establishment and Survival of Yellow Poplar Following a Clear Cutting in the Southern Appalachians," which has been submitted to the Journal of Forestry, the results to date of a study begun in 1925 were set forth. This study was concerned with the failure of yellow poplar reproduction on two plots at Bent Creek. The conclusion reached is that the most obvious cause of failure was the root and light competition offered by the dense herbaceous cover which came up after the cutting.

A preliminary analysis of the data from the extensive survey of cut-over lands was made and the results published in the bulletin "Timber Growing and Logging Practice in the Southern Appalachian Region." These data indicate that the average cut-over stand in this region is only about half stocked with trees over three inches in breast high diameter, and that 70 to 80 per cent of the trees making up this stocking are of poor form or of less desirable species. The reproduction is not particularly promising since more than half of it is shaded and will be hindered in its growth. Of the reproduction free to grow, more than half is of less desirable species.

As a result of the first year's work in forest management in Georgia a 32 page bulletin entitled "Forests of the Georgia Highlands" was published as Bulletin 15 of the Georgia Forest Service. It gives general data on importance of the forests of the region to watershed protection and recreation, and more specific information as to the extent, composition, and productive value of the forests. General recommendations for improvement cutting and thinnings are made.

Future work

Future work of this project is to follow the lines already outlined. One of the first things planned is the preparation of a report on the extensive survey of cut-over areas under some such title as "Natural regrowth on unburned cut-over lands in the Southern Appalachians."

In addition to the routine work of sample plot remeasurements it is planned in the near future to establish one or two more sets of from 3 to 5 plots to study the release of white pine reproduction under defective hardwoods on the Cherokee National Forest.

A study to determine the conditions necessary for the successful establishment of yellow poplar reproduction is planned. The problem is to be attacked from two approaches:

(1) By quantitative measurements and modification of certain environment factors, those which govern the establishment of reproduction of the species will be determined.

(2) Practical ways to obtain proper seed bed conditions in the woods where an abundant supply of seed is assured will be sought by girdling wolf trees to produce openings in the canopy, and treating the soil beneath these openings in various ways.

Management - Coastal Pine Forest

The rapid tree growth, relatively large timbered area, ease of logging, and ease of transportation to the main lumber consuming centers are advantages that give the Mid-Atlantic coastal plain great promise for commercial timber growing. The future of commercial timber growing, however, rests on a knowledge of the methods of forest management which can be applied to the various species. With the small funds available the work to date has been limited to a few of the questions which must be answered before the management of loblolly pine can be put on a sound basis.

The work now under way may be divided into four major parts, the objects of which are to determine (1) the nature and extent of reproduction on burned and unburned cut-over loblolly pine lands; (2) the changes in growth-rate and form of loblolly pine left after partial cutting; (3) methods of cutting which will result in a satisfactory restocking of loblolly pine stands at the same time that high net returns are realized; and (4) cultural methods for bringing loblolly stands to rapid maturity, improving their composition and increasing their rate of growth.

Past work

Under the first subdivision of the project a preliminary extensive survey was run in 1927 which yielded data on the extent and nature of

reproduction on both burned and unburned cut-over loblolly pine lands. This survey was continued in 1928. A preliminary analysis of the data obtained shows very harmful effects of fire on loblolly pine reproduction. But further field work to cover additional conditions is necessary.

During the course of the extensive survey, data for the second subdivision of the project were obtained from measurements of the growth of 1500 trees left standing on logged areas. In 1928 a special investigation of the change in form of trees left after logging was begun. The conclusions drawn from a preliminary analysis of these data are given under the heading "Results of the past year."

Studies in the third subdivision of the project - methods of cutting to yield satisfactory reproduction along with profit from the operation - have been undertaken in cooperation with the Forest Products Laboratory. In the autumn of 1929 detailed studies of logging and milling costs and financial returns were made by the Laboratory at Franklin, Va., in cooperation with the Appalachian Station and the Camp Manufacturing Company. On the area cut over the Station established six 1-acre sample plots in six 2-1/2 acre study areas, in a mixed stand of loblolly pine and hardwoods. These areas were marked for a selective cutting and were cut over and treated in different ways. Measurements and counts to study the establishment, development, and growth of reproduction under controlled conditions will be made on the 1-acre sample plots.

This cooperative work with the Forest Products Laboratory was carried further in 1930, in connection with a second study of logging and milling costs in an old field stand of loblolly pine on the lands of the Foreman-Blades Lumber Company, near Windsor, N. C. Four 2 acre plots were established by the Station and subjected to different degrees of cutting, from light to heavy, in order to determine the effects on the growth of the remaining trees and on the establishment and growth of subsequent reproduction.

The most recent work under this branch of the project will be taken up under the heading of "Results of the past year."

The fourth subdivision of the project - cultural methods for improving the composition and growth of stands of loblolly pine - has followed two lines. The first is concerned with liberation cuttings to free loblolly pine reproduction. On the plots established at Franklin, Va., in 1929, various methods of treating undesirable hardwoods, which remain after the cutting, were tried. Preliminary results of this work are given under the heading "Results of the past year."

The second kind of cultural method is thinnings. Three sample plots were established in a stand of shortleaf pine on the Page Estate, Hanover County, Va., during 1913. Two of these plots were thinned and the third was left as a check. They were examined in 1919, 1925, 1930.

The data have not been analyzed. Five plots established in 1925 in a stand of longleaf pine on the Southern Railway Demonstration Forest, at Fregnall, S. C., were taken over by the Station in 1930, remeasured, and enlarged from .229 to .25 acres each.

Results of the past year

In 1931 four 2-acre sample plots were established near Charleston, S. C., in connection with a third study of logging and milling costs conducted by the Forest Products Laboratory. The plots are for the purpose of comparing stands cut over with different degrees of severity.

The data from the study of logging and milling costs conducted in 1929 by the Forest Products Laboratory and the Appalachian Station on the lands of the Camp Manufacturing Company at Franklin, Va., were analyzed during the year and presented in Bulletin No. 43 of the Virginia State Forest Service. This analysis showed that it was unprofitable for a large stationary mill to cut and manufacture trees less than 13 inches d.b.h. On the other hand, the results of a similar study at Windsor, N.C., which have been compiled and are now awaiting publication, show that a small, portable band mill could cut trees as small as 11 inches d.b.h. and still realize profit.

The preliminary results of the study of poisoning, felling and girdling of undesirable trees on sample plots at Franklin, Virginia, were prepared for publication in the Journal of Forestry during the year and appeared in the February, 1932, issue. Poisoning with sodium arsenite solution introduced in axe cuts was found to be considerably cheaper and more effective than girdling or felling.

An analysis, made in 1931, of data collected in 1927 and 1928 indicates that the growth of loblolly pine trees left standing on logged areas increases materially after liberation and that trees which were completely liberated by the removal of all trees within 30 feet of them grew as fast after liberation as trees of the same class which had never been subjected to competition. These data also indicate a tendency of released trees to grow more rapidly in diameter above breast height, which is the usual point of measurement, than at breast height.

Future work

Future work on this project will continue along the lines that have been outlined above. The study of the nature and extent of reproduction on cut-over loblolly pine lands will be expanded to include conditions not yet investigated. It is hoped that these data will warrant the presentation of broad recommendations for the management of cut-over loblolly pine lands.

The analysis of the data on increased growth of trees left following partial cuttings is to be completed and published.

Considerable time will be spent during the coming year in the routine reexamination of the three sets of plots established to study methods of cutting.

No further thinning plots will be established until lands with assured long-time tenure of ownership are available for the establishment of permanent sample plots.

A working plan for the project will be prepared during the ensuing fiscal year.

Protection - Fire Damage

Fire studies at the Station for the past five years have been confined to investigations dealing with the effects of forest fires. Work has been concentrated on the mountains and coastal plain and has been directed toward determination of the effects of burning on site, regeneration, and stand. Thus broadly stated, the immediate objectives of the work in both mountains and coastal plain are similar. In ultimate objective, however, there is some divergence. The mountain studies are designed to yield information pertinent to the appraisal of fire damage, the formulation of protection policies, and to the restoration and management of fire damage areas. The coastal plain studies, on the other hand, are expected to establish the desirability or undesirability of annual burning in the longleaf and loblolly pine types. The mountain study deals with the determination of methods for measuring damage as reflected in the reduced productive capacity of the forest; the relative resistance, and factors influencing resistance, of different tree species to fire, and their recuperative ability; and the effect of fire on site as indicated by soil changes and the subsequent capacity of the soil to support plant growth. The coastal plain study emphasizes the effect on reproduction, but from the point of view of testing the alleged benefits and the injuries from controlled burning.

According to plans of the United States Weather Bureau, research in forest fire weather forecasting is to be started in March, 1932. While this subject is not within the scope of fire damage investigations it is very closely related, and the Station desires to cooperate as far as practicable by furnishing data as to the deposition and accumulation of fuel under different forest conditions.

Past Work

Mountain hardwood forest: During the early investigations on forest fires in the mountain region emphasis was placed on the study of fire weather and fuel, and on extensive surveys of burned areas. Plots were also established for the purpose of learning the continued mortality in stands as well as their recovery after fire. Later, greater attention was given to the effect of fire on forest soils. Methods for studying

changes in the physical character of the soil, and for studying decomposition of litter under controlled laboratory conditions were devised. Recently, a study of basal wounds was begun, and an experimentally burned permanent plot with adequate controls was established.

Coastal pine forest: The work on the coastal plain has so far been confined to two sets of permanent sample plots. One set of plots was established at Lanes, S. C., in 1924, and rehabilitated in 1929. These comprise nine plots protected from all fire and fourteen burned annually. Since 1929 the reproduction quadrats on the unburned plots have been examined annually, while those on the burned plots have been examined twice each year.

The other set, consisting of two 1/3 acre plots, was established near Summerville, S. C., in 1930. One of these plots was located in a stand of longleaf pine which had been burned annually for thirteen years, while the other was established in a contiguous stand which had been protected from fire for the same period. These plots are expected to furnish valuable information on the effect of annual fires upon rate of growth and soil conditions. A summary of the early results is given under the next heading.

Results obtained in 1931

Mountain hardwood forest: During the past year data on basal damage, collected from an area at McFalls Creek, Va., which had been burned in the spring of 1930, were subjected to statistical analysis and a correlation found between size of exterior discoloration and interior wound. A simplified field method for measuring external discoloration, from which the wound is predicted, has been developed which, if applied to a sufficient number of trees, gives a reasonably small error of estimate. Of the five important species on the area examined, it was found that, for a given diameter and area of discoloration, yellow poplar showed the smallest wound and scarlet oak the largest; white oak, chestnut oak, and black oak were intermediate, their relative order depending somewhat on the particular diameter and size of discoloration which was selected as a basis for comparison.

The usefulness of the present basal damage study, even for appraisal purposes, will depend on the results of further studies of the effect of basal wounds on growth and the entrance of heart-rotting fungi. Such studies, together with those on the susceptibility of species to basal wounding, will be of great aid in guiding silviculture on areas subject to forest fires.

Hardwoods killed by fire commonly produce an abundance of basal sprouts. Preliminary observations made on the McFalls Creek burn within a year after the fire indicated no correlation between degree of sprouting and severity of basal wound on trees which survived. It appears that the number of basal sprouts is not a reliable index of the extent of basal wound.

The McFalls Creek burn in common with other burned over hardwood areas in the region showed an abundance of fungus fruiting bodies the second summer after the fire. The first micro-organisms appeared on the wounds beneath the bark within a few months after fire, and consisted chiefly of yeasts, bacteria, molds, and the sap-rotting fungus Nommularia. These were followed later by other sap-rotting fungi, Daldinia, Schizophyllum, Pleurotus, Polystictus, and various species of Stereum.

The factors which determine the degree of susceptibility of a tree to basal damage are intensity of fire, and thickness and character of the protecting bark. Experimental methods for comparing the insulating properties of different barks at different seasons have been devised. With the low experimental temperatures applied to the outside of the bark, an increase in bark thickness of as little as 1/10 inch, very decidedly increased the time required to kill the cambium. The completion of these studies will provide accurate information on the relative resistance of species to basal damage, and on the factors which influence resistance.

Improvements were made in methods of estimating the annual deposition of litter on permanent plots at Bent Creek. The estimated oven dry litter in a pine-oak stand, on an acre basis, on the two untreated plots was about 13,000 pounds, a two years deposition on the burned plot was about 7,300 pounds, and one year's litter from the raked plot amounted to approximately 3,200 pounds, about one-fourth more than was removed last year.

Yearly estimates on these, and other burned plots when established, will furnish information on yearly variations in leaf fall, on how crown damage affects the production of leaf litter, on the recuperation of crowns after damage, and on the rate of decomposition of leaf litter on different sites. All of these have an important bearing upon fertility of forest soils and upon the growth rate and thrift of the forest.

Coastal pine forest: Significant results showing the effects of annual burning over a period of 13 years came to light when measurements taken on the two comparative plots near Summerville, S. C., were compiled. Data were available from 45 trees on these plots, 29 on the burned and 16 on the unburned, for the entire period of 13 years. The following table summarizes these figures:

	: Year :	Annually :	Protected
	:	burned :	area
	:	area :	:
Height (feet):	:	:	:
Average	:(1916 :	5.0 :	6.1
	:(1929 :	29.9 :	37.1
Average total 13-year increment.....	:	24.9 :	31.0
Average annual increment.....	:	1.92 :	2.38
Deficiency on burned area.....	:	.46 :
Diameter at breast height (inches):	:	:	:
Average.....	:(1919 :	2.57 :	2.63
	:(1929 :	5.47 :	5.82
Average total 10-year increment.....	:	2.90 :	3.19
Average annual increment.....	:	.29 :	.32
Deficiency on burned area.....	:	.03 :
Cubic volume peeled wood per tree.:	:	:	:
(cubic feet):	:	:	:
Average.....	:(1919 :	.204 :	.246
	:(1929 :	2.151 :	2.731
Average total 10-year increment.....	:	1.947 :	2.485
Average annual increment.....	:	.195 :	.249
Deficiency on burned area.....	:	.054 :

The averages under the two conditions show that the unburned trees grew faster in height, diameter, and volume than the burned trees. In height growth this superiority amounted to 19 per cent, in diameter growth 9 per cent, and in volume growth 22 per cent.

Future work

Mountain hardwood forest: Physical damage to roots, boles, and crowns is reflected in a reduced growth rate of the injured trees. If quantitative data are to be obtained on this reduction, experimentally burned permanent plots with proper check plots must be available, on which it has been possible to record the physical condition of the tree, together with information on growing stock, fuel, and soil conditions, and other pertinent information, prior to burning. Periodic comparisons of the burned plot with the unburned check plots, will then provide data not only on growth but on continued reduction in growing stock, possible changes in type of reproduction and vegetative cover, the effect on soil, and other undesirable or desirable changes which occur as the result of fire. Such results are, of course, applicable only to burned areas similar to those studied; but accurate data of this sort are badly needed and should be obtained for as many types as possible with the funds available.

Growth studies on the permanent sample plots should be supplemented by others on old burns. Methods to be used on these supplementary studies have not as yet been fully worked out, but will probably involve comparison of increment cores from burned and unburned areas.

Laboratory experiments on the relative insulating properties of bark of different species at different times of the year will provide information on the differences in susceptibility of species to basal wounding and will supplement the field data at hand. This experimental work will also indicate the degree to which field work on basal damage needs to be extended in order that the available data may be widely applicable.

The following subdivisions of the project, all bearing on the effect of physical damage to trees by fire, will receive the chief emphasis during the coming year:

1. Location and establishment of a second permanent plot for experimental burning, with an adequate control plot.
2. Investigation of reduced growth on old burns.
3. Bark insulation studies.

Proposed studies for the future include:

1. The effect of basal wounding on the growth rate of trees.
2. The seasonal and species differences in the thermal death point of cambial cells.
3. The effect of forest fires in modifying the rooting habits of trees.
4. Root-suckering and the role of fire in promoting or hindering it.
5. Crown injury and its relation to growth rate.
6. Rate of healing of basal wounds caused by fire.
7. Influence of fire on change of type.
8. Deposition and accumulation of fuel under different forest conditions. (Subject to possible cooperative agreement with the Weather Bureau.)
9. The effect of basal wounding on rate and path of sap movements.

Coastal pine forest: The reproduction quadrats on the Lanes plots will be re-examined during the fall of 1932, and the one area burned over again if there is sufficient fuel to carry the fire. One of the Summerville plots, also, will be burned over.

Mensuration - Mountain Hardwood Forest

A knowledge of the rate of forest growth is indispensable for forest management, since without it forecasts of future returns are merely speculations. Because of the great differences in the composition, age, and condition of the mountain forests this subject calls for a comprehensive attack requiring more personnel and travel funds than can be spared from the Station's present allotment. As originally planned, the work under this project was to be concentrated largely on juvenile stands. However, from the special funds allotted for work in North Georgia, a small sum was assigned during the past year to the study of growth in older stands. Further amplification of the project with particular reference to the growth rate of uneven aged and understocked stands has been recommended for inclusion in the Station's program as soon as funds for it can be provided. Thus far the project has been financed from the allotment for the general management project.

The purpose of this project is to learn from observations of the growth on measured sample plots (1) the actual growth taking place in various forest types and condition classes; (2) the relation of different qualities of site to the growth rate; (3) the best stocking of stands and the relation of present stocking to future growth rate; (4) the rotation ages for different tree species and products; and (5) the best survey technique for making growth forecasts.

Past Work

Two sets of plots in juvenile stands have been established. In 1926 a pair of permanent plots each 0.4 acre in size was established on Star Gap Branch, Pisgah National Forest. During the same year another pair, each 0.5 acre in size was established in an old field type on the Berea College tract.

Results of the past year

In 1931, 61 chains of permanent strip amounting to a 46 per cent estimate were established in the Sosebee Cove stand of yellow poplar in Union County, Ga. This stand is often mentioned as the best second-growth yellow poplar in the southern mountains, yet heretofore very little detailed information about it has been available. The data and maps resulting from this study will give information on the productive capacity of this unusual site and serve as a basis for future studies of yellow poplar regeneration on adjacent areas.

A strip consisting of 18 contiguous 0.1 acre plots was established in the southern red oak-black oak-white oak type on the woodlands of the Georgia Mountain Experiment Station, at Blairsville. This is the first of what is hoped will be many such strips for the purpose of determining actual wood production on representative forest areas. This type is one of the most widespread of the forest types, in the broad mountain valleys of the southern Blue Ridge country, and therefore is particularly important from the viewpoint of farm management.

Future work

The establishment of one additional growth strip in North Georgia is planned for the fiscal year 1933. The Berea and Star Gap Branch plots will be re-examined during the coming season. Additional plots in juvenile stands will be established as opportunity presents itself. Establishment reports for the two plots initiated in 1931 and progress reports for the Berea and Star Gap Branch plots will be prepared.

Planting

The scope of the planting studies has been, and is, restricted to testing the suitability of various native and exotic species for planting on two sites, the high spruce-fir country, and the lower pine-hardwood belt.

Past work

Although the planting work has been handicapped by low priority and inadequate funds, a number of species have been planted in small plots in both the types. Over 80 test plots of 100 trees each have been established in the spruce-fir type in the Black Mountains of North Carolina. Seventeen coniferous species have been tried, some in replicate and with stock of different age and class. The plantings at lower elevations in the Bent Creek Valley have been of two sorts, arboretum plantings of a few trees of each species, and larger plantations. About 50 species have been planted in the arboretum, and fewer species in the larger plantations.

Results of the past year

During 1931 four additional test plots were established in the spruce-fir type, two each of Sitka spruce and white spruce. In the Bent Creek arboretum, dead trees were replaced in 6 plantings and 3 new plantings were made. One new large plantation was established at Bent Creek, about an acre of Japanese red pine; and the dead trees in a red pine plantation were replaced. No seed was sown in the nursery.

Summarized results of the tests in the spruce-fir type were published, in part, in U. S. Department of Agriculture Technical Bulletin 250.

Future work

For the fiscal year 1933 activity on the planting projects will be confined to measurement and observation of the existing plantings and preparation of a progress memorandum.

Plans for the prosecution of the many interesting and worthwhile investigations in the use of planting for the rehabilitation of mis-handled forests and agricultural land in the region must necessarily be held in abeyance because of lack of funds. The studies merit attention and should be begun soon so that the results may be available when the time comes to put them into practice generally.

Botanical Studies - Phenology

It is the purpose of this project to build up a fund of information on the seasonal changes in the life processes and on the periods of growth of forest trees and associated plants as they are affected by climate and geography throughout the Station's territory, and to so analyze and correlate this information that it may be of most value as a guide to timing silvicultural operations.

Past work

The project was begun in 1929. Only a small amount of time could be spent on it so that during the first two years the work was confined to the development of a technique for collecting phenological data. Since it is difficult to describe in words, for the instruction of observers, the exact conditions which are to be recorded, a large number of photographs were taken periodically to show the development of vegetation during the growing season.

Work of the past year

A tentative scheme for the collection of phenological records was devised and sent, early in 1931, to about fifty persons who were invited to become cooperative observers. In the selection of this list of people the Station was helped by a committee of the Appalachian Section of the Society of American Foresters.

Records for 1931 have been received from only five of this list of fifty persons. It is evident that with the limited amount of time that can be spent on this project, little progress can be made.

Future work

For the present this project is apparently bound to be limited to work which can be done by correspondence from Asheville. During the coming fiscal year another attempt will be made to reach persons whose interest in the work is more than casual, and to obtain help from them.

Since no revision in the scheme for the collection of data has been indicated the same forms will be used again and sent to a list of persons who express in writing their willingness to cooperate with the work.

FOREST INFLUENCES

Streamflow and Erosion

The purpose of the streamflow and erosion investigations is to determine the function of forest or other natural vegetative cover characteristic of forests or wild land in the regulation of streamflow and control of erosion, and the form in which such cover will be most effective.

Past work

The project has been under way only since the beginning of the current fiscal year. For this reason the activities have been concerned chiefly with orientation and analysis of significant problems and the study of methods and procedures suitable for developing the study within the Station's territory.

Although the project as such has not been long in existence, the subject of streamflow and erosion has entered into certain of the Station's activities in the past and observations that have been made in connection with other projects furnish important data useful to the development of the streamflow project.

In connection with soil studies conducted in 1929, observations were made on the soil conditions on abandoned mountain farm land along the French Broad River in Western North Carolina. It was brought out by this study that in certain sections of the mountains from 60 to 80 per cent of the mountain land once used for agriculture has been abandoned and is now idle. Much of this land is subject to severe erosion and some of it has been devastated by sheet and gully erosion and is no longer suitable for agricultural use. In part of this land, deep gullying has been proceeding to such an extent that the land has become a serious menace in silting up the streams. The observations have been reported by the Station in the Department of Agriculture Year Book, in the Farmers Federation News and elsewhere.

During 1931, as a part of the smelter fume damage studies in Southeastern Tennessee, observations were made on the rate and severity of erosion taking place on mountain land where no vegetative cover is present. Coincident observations on abandoned fields in the same region which were not subject to smelter fume damage indicated that complete devastation of the land may take place on certain soils in this region where they have been abandoned for agriculture following a clean cultivated crop. Reports of these observations are available.

The fire damage and raked plots on the Bent Creek experimental forest, installed in 1930 as a part of the soil phase of the fire damage study, have furnished an excellent opportunity to study the influence of burning away the litter upon erosion and surface run-off. These plots, consisting of one 1/2 acre plot from which the litter has been raked annually, two 1/2 acre plots that were severely burned in the spring of 1930, and two control plots, will be used for further studies of surface run-off and erosion.

The Biltmore Estate white pine plantations are essentially a study of plantation growth on worn out farm land. The land on which these white pine plantations were set out was at one time so severely eroded that check dams and brush barrages were required to check further soil washing until the trees became established. These plantations indicate that forest plantings are effective in checking erosion on abandoned fields and at the same time produce a profitable financial return.

The Station's observations in North Georgia and elsewhere indicate that where seed trees are available, shortleaf and Virginia pine have taken abandoned farm lands naturally, completely checking further erosion and producing a profitable crop of pulpwood.

In addition to the above observations on erosion of abandoned farm land, the streamflow and erosion project is able to profit by observations begun under the study of fire damage to soils on the conditions of the humus layers within the region as they are influenced by the forest cover type and by cutting and burning. As water retention and erosion conditions are governed largely by humus layers of the soil, it is apparent that the above mentioned observations will be useful as a starting point from which to continue the erosion study.

During the summer of 1927 the Station furnished the part time assistance of two men in compiling the report on forest conditions within the Ohio River watershed as related to floods and run-off waters. This report was incorporated as a part of House Document 573, on the relation of Forestry to the Control of Floods in the Mississippi Valley. Subsequently, in 1928, Dr. C. F. Korstian made a study of the influence of forest cover upon the load of suspended matter carried by streams in flood stage in the vicinity of Asheville, N. C. It was brought out by this study that the amount of suspended matter in streams with 90-95 per cent forested watersheds was from 4 to 11 parts per million. The suspended matter in the streams under such conditions consisted of organic matter such as leaves, rotted wood, etc., and a small part fine sand. The suspended matter in streams from watersheds with 30-35 per cent forest cover amounted to over 3,000 parts per million and consisted largely of clay, capable of being carried long distances. This report also appears as Appendix IV, in House Document 573.

During 1928 the Station prepared a report also incorporated in House Document 573 on litter conditions met with in the hardwood forests of the Southern Appalachian Mountains. This report was based on field measurements of litter under different forest conditions. It brought out the influence of slope and aspect upon the rate of decomposition of the litter. Also it was shown that the influence of litter upon water relations is not expressed in its own water holding capacity so much as in its effect in maintaining the upper mineral horizons of the soil profile in a porous and absorptive condition. It was brought out in this report that the increased water retention due to the annual litter return would be equivalent to 400,000 pounds per acre in the upper six inches of the soil. This increase in soil water retention was ten times the actual amount taken up by the litter itself. Further measurements have been made from time to time as a part of the fire damage project.

Work accomplished during the past year

As an important preliminary to beginning local streamflow and erosion studies using field instrumentation methods, a visit was made by the project leader to a number of field stations in other parts of the United States where such studies are now in progress. Observations made during this tour will serve as a basis for developing methods and instrumentation suitable for the Southern Appalachian region.

Although the Station has not as yet made any extensive experimental studies using catchment basins and recording instruments, some field tests have been started to determine what type of apparatus is most suitable for studying surface run-off on small unit areas of mountain vegetation. These tests indicate that because of steep slopes, rocks, and irregular spacing of stems and exposed roots, installations that are suitable on the more even terrain of the Western States, may not be directly adapted to the southern mountains. Attempts will be made to test out such modifications as appear to be most likely to be successful for local conditions.

Most attention has been directed toward the comparison of the effect of forest and other vegetative cover upon streamflow and erosion conditions. In general it has been observed that erosion is never serious on mountain areas where the natural vegetation has been undisturbed. An occasional gully may occur, starting from a skid trail after cutting. Also some washing of charred duff and some soil may follow severe burning until another vegetative cover becomes established. For the most part, however, it appears that where the natural organic layers of the soil have not been completely destroyed, erosion is insignificant on forested lands. On the other hand, whenever the natural cover has been removed for agricultural purposes, severe erosion has usually resulted. Particularly has this been true where corn, cotton, and tobacco have been grown. Consequently the erosion phase of this project concerns itself largely with areas which have been cleared and subsequently abandoned for agricultural use. The amount of this land varies from 80 per cent of the total in some piedmont counties, to a minimum of 20 per cent in the more mountainous counties.

Future investigations, fiscal year 1933.

It is proposed for the present to proceed with the streamflow and erosion study primarily with the effort to determine the relative efficiency of different types of vegetative cover in governing stream water movements through the organic layers of the soil. No extensive experimentation is planned at present in eroding lands other than may be carried out in cooperation with different projects of the Station.

The identification of the humus soil layers as they occur under different types of forest cover will receive principal attention for the immediate future, as this is considered to be one of the most important phases of the streamflow problem. A report summarizing known facts as to the relation of different types of humus layers of the forest to streamflow and erosion in the Southern Appalachians is in preparation.

Field tests will be made to determine the most suitable means to study the water economy on representative small units of vegetation. Methods will be investigated for measuring the factors governing precipitation run-off; also evaporation from the soil itself and other soil water relations in so far as they enter into the problem.

Observations of plantings and natural restocking on eroding farm land will be continued, as well as observations on the gradual changes in organic horizons on abandoned farm land. While no systematic extensive survey is planned, it will be considered an essential phase of the project to observe and compile, whenever possible, accurate data indicating location, nature, and extent of eroding lands within the Station's territory.

FOREST ECONOMICS

Extensive Revision

A revision of statistics issued by the Forest Service in 1920, and published as Senate Document 311, 66th Congress, under the title "Timber Depletion, Lumber Prices, Lumber Exports, and Concentration of Timber Ownership," was undertaken by the Forest Service in 1931. The States of West Virginia, Virginia, North and South Carolina were assigned to the Appalachian Station. This project did not involve much field work but consisted in the compilation of the best data available from all sources as to the area and condition of timberlands, their ownership, and the stand of timber by forest types, age class (old-growth and second-growth). The project also called for estimates of depletion by utilization, fire, disease, insects, wind, etc., and of the rate of growth of the forest under classes as above mentioned. Much correspondence with cooperators was undertaken and a series of conferences, involving special trips by members of the Station staff. Excellent cooperation was received from state foresters and private foresters in the region, as well as from several large

manufacturing plants in possession of statistics of production. Statistics of area, stand, growth, and depletion were submitted on a series of over thirty forms, uniform with those presented for all the other forest regions in the country. A series of reports on the utilization of various forest products was prepared, one for each of the four States assigned to the Station.

This project has been set up in the Station's program and will be continued with a small allotment to take care of any work that becomes necessary throughout the year.

BIOLOGICAL INVESTIGATIONS

Thos. D. Burleigh, Associate Biologist.

U. S. Biological Survey.

Past work

Biological investigations dealing with the relationship of wild life to forests were inaugurated January 1, 1930. These investigations fall into two groups, relating to means of increasing game and fur-bearing animals, and to the activities of birds and mammals which affect the reproduction and thrift of the forest and hence of silvicultural practices. A knowledge of the distribution and abundance of the many species of birds and mammals native to the region is essential to both these lines of investigation, and observations have accordingly been carried on intensively since the beginning of the work. Another essential is a knowledge of life histories of important species, particularly food habits. Food habits have a very direct bearing on any actual relationships; and with this idea in mind, systematic collecting has been carried on and the stomachs of all specimens carefully preserved for later analysis. At the start, activities were limited to Western North Carolina, but the scope of these investigations has been gradually widened to include both the piedmont and coastal plain regions of North and South Carolina and the mountains of West Virginia.

Of necessity, the two subjects of game management and relation of birds and animals to silvicultural practice have been correlated to a certain extent, as in the relationship of the larger predatory mammals to rodents, but definite projects have nevertheless suggested themselves. In the field of game management, an abundance of such predators as wild cats and foxes seemed the possible reason for the scarcity of both ruffed grouse and quail, and to test this theory an attempt has been made, by the use of steel traps, to reduce their numbers to a minimum on the Bent Creek experimental forest and observe the results. Present laws forbid the use of steel traps throughout the mountain counties; and as foxes are likewise being imported by local fox hunters, the effect on upland game birds might well be disastrous. Deer management, to be successful, demands a thorough

knowledge of food habits; and here the analysis of stomachs taken during the fall and early winter should yield information of considerable value. This will likewise involve silvicultural practice, for the effect of these animals on the reproduction of important forest trees has long been a matter of conjecture.

In the field of silviculture, rodents - particularly various species of mice which feed on tree seeds - are sometimes blamed for the failure of desired species of trees to reproduce. Rodents are known to fluctuate in numbers over a period of years, but what their minimum and maximum numbers are on varying sites, and just what their effect is on forest growth, are matters of real interest at this time. To obtain reliable data that will answer such questions, consistent trapping has been carried on throughout the year on as varied sites as possible, extending from the rhododendron thickets fringing the streams in the valleys, to the spruce and fir woods of the higher mountains. Recently this phase of the work has been enlarged to include the effect of severe forest fires on the rodent population.

Work accomplished during the past year

Activities pertaining to biological investigations have been rather varied during the past year, and have involved many phases of the work.

Deer studies in Western North Carolina were supplemented by a week of intensive field work in the tidewater counties of Virginia where, in company with Vernon Bailey, Chief Field Naturalist of the Bureau, such matters as sex ratios, minimum and maximum numbers on given areas, and food habits were taken up in more or less detail.

Game management was also involved in the liberation of four beavers (three females and a male) on suitable lakes on the Biltmore Estate and on Bent Creek. Over sixty years ago these animals, once numerous in this region, were exterminated in the Southern Appalachians; but it is hoped that with this nucleus they may in time regain, to some extent at least, their former numbers. Success in this undertaking would mean not only adding a valuable source of fur to this part of the State but also aiding, to no small extent, the control of streamflow in this rough mountainous country.

The prolonged drought during the late summer and fall resulted in an extreme fire hazard, with numerous forest fires, some of which were of considerable extent. This afforded an exceptional opportunity to study the effect of such fires on the wild life of the mountain slopes, and with this object in view a burned area relatively accessible and of sufficient size to warrant its use was selected for such an intensive study. Sample quarter-acre plots representing the various types found in this region have been laid off, and preliminary work started dealing with the effect of fire on rodents. This will be closely correlated with the food habits of these mammals on burned areas, as this will undoubtedly have a decided bearing on future reproduction of desired timber trees. Other studies will include the effect of such fires on the predators, both birds and mammals, and on game birds such as the ruffed grouse and wild turkey.

The study of life histories and of distribution and abundance was materially broadened during the year to include parts of the region until now ignored. Two weeks in January were spent on the coast of North Carolina, two weeks in June in the mountains of West Virginia, and a week the latter part of October in the Okefenokee Swamp in Georgia. Brief field trips were also made to the piedmont section of North Carolina, South Carolina, and Georgia, as well as to the Great Smoky Mountains, lying on the boundary of North Carolina and Tennessee.

Plan of work for the fiscal year 1933

The fire study: This phase of the work will be given precedence over all other projects and will be carried on in considerable detail. Practically nothing is now known concerning the effect of forest fires on the wild life of the Southern Appalachians, but the importance of such knowledge from the standpoint both of game management and of silvicultural practice needs little comment. Tentative plans now approved will undoubtedly be changed from time to time as new facts are brought out.

Distribution and life histories: These studies will be continued on the same basis as during the past year, with the thought in mind that biological reconnaissance will be carried on in parts of the region concerning which little is now known. Data so secured will be correlated as closely as possible with information already available for the Southern Appalachians.

Game management: In addition to the work indicated under the fire study, game management investigations will include the trapping of predatory mammals on the Bent Creek experimental forest and close observation on the effect on upland game birds of the reduction of these predators.

Food habits: As during previous years the stomachs of all birds and mammals trapped or otherwise taken will be preserved for careful analysis. In no other way can actual relationships be definitely determined beyond question of doubt. Problems now rather perplexing, and difficult of solution, should be materially aided by sufficient data of this nature.

FOREST PATHOLOGICAL INVESTIGATIONS

R. M. Nelson, Formerly Assistant Pathologist

Bureau of Plant Industry

Work in forest pathology at the Station was carried on from April 1927 to August 1931. Following is a list of the projects which received most attention, and a summary of the results obtained during the period.

Chestnut blight investigations

1. Data obtained in scouting for chestnut blight, together with those obtained by other investigators, predicted the rapid spread of the disease in the Southern Appalachians.

2. A large number of wood specimens from dead chestnut trees were collected. Analysis by cooperating chemists indicated that the wood of chestnut from trees dead for as long as 20 to 30 years could be used for the production of tannin unless badly decayed.

3. Experiments with chestnut sprouts demonstrated that the removal of all except the most vigorous sprout from the bases of stumps did not materially increase the growth rate of such sprouts and that because of the rapidity of infection of sprouts by blight at the present time, such treatment is not suitable for the production of acid wood.

4. Approximately 9,000 oriental chestnut seedlings have been planted on or near the Bent Creek experimental forest.

Experiments with bluestain fungi in living pines

1. Pines successfully attacked by the Southern pine beetle invariably become bluestained before death which occurs within a few weeks after attack.

2. This constant association of insects and fungi, together with the phenomenon of specificity - the association of a specific blue staining organism with a specific bark beetle - indicate that the insects carry the blue staining fungi into their tunnels and thus inoculate the infested trees.

3. The fungi grow chiefly in the ray parenchyma cells and resin ducts; to a lesser extent in the wood and ray tracheids.

4. Stained sectors in the sapwood block the upward flow of the transpiration current. The water content of the bole is thus reduced, a condition which apparently is necessary for proper beetle brood development.

5. There is some evidence that the action of the fungi in the rays causes aspiration of the tori in the bordered pits of the water conducting tracheids and thus excludes them from the conducting system.

6. Tunnels made by bark beetles are sufficient to kill pines in time, but the immediate cause of death is the action of associated blue stain fungi.

Decay in loblolly pine on the coastal plain

An examination of decay in 867 loblolly pines was made in connection with the selective logging study at Franklin, Va. Red heart caused by Trametes pini was the only important type of decay and was found in 11 per cent of the trees. The percentage of trees infected increased from 5 in the 40-90 year age class, to 19, 60, and 72, respectively, in the 90-140, 140-190, and 190-230 year age classes. Sporophores were the only infallible sign of decay and the length of infected bole on the 15 trees that bore sporophores averaged 50 feet. The amount of lumber obtained from 73 of the 141 decayed logs lay roughly midway between the gross and net scale.

Data from a similar study in South Carolina have been collected but not yet analyzed.

Basal wounds in mountain hardwood caused by fire

Results of this cooperative study are summarized elsewhere in the report.

The collection of cultures and specimens of heart rots in this region has been augmented from year to year. At present more than 800 specimens and 400 cultures are available for study.

During the period 1927-1931, four papers were published and four others were prepared for publication.

FOREST INSECT INVESTIGATIONS

R. A. St. George, Associate Entomologist

Bureau of Entomology

Results of the Past Year

The investigative work for the season 1931 was begun in June with the arrival of Field Assistants R. W. Caird, from the University of Michigan, Noel D. Wygant, from Purdue and B. J. Huckenpahler and Lyall E. Peterson, from the University of Minnesota. R. A. St. George was in charge of the work which, as in the preceding five seasons, largely centered around a study of the southern pine beetle (Dendroctonus frontalis Zimm.).

I. Beetle Abundance

Soon after the work was begun it was apparent that the heavy spring emergence, anticipated from the large number of brood that had bred up during the previous dry fall, had not occurred. It is believed that this natural control was due to continued warm weather during the late fall, which caused the premature emergence of beetles which usually overwinter, and the unfavorable condition of the trees attacked by those beetles. Large numbers of the brood were also destroyed by woodpeckers before emergence.

II. Tree Injection Studies

Poisonous solutions were injected into the sapstream of healthy and of beetle-attacked trees for three purposes: (1) to find new and cheaper chemicals effective in the control of bark-beetles in infested trees; (2) to determine the possibilities of treating poles for rustic purposes before felling, so that the bark would not be destroyed subsequent to cutting; and (3) to preserve the wood of barkbeetle-attacked and of healthy trees by protecting it from subsequent insect attack and decay.

1. For brood control. A further test was made of those chemicals that gave the most promising results the previous year and they were again found to be effective. Other new chemicals were tried which had been proven by the office of Forest Pathology to be excellent fungicides in preventing the development of moulds and stains on green lumber. While these were found to be promising as fungicides, they were not toxic enough to be considered favorably as effective insecticides.

It was noted that infested pine trees must be injected while freshly attacked to obtain optimum results for conduction and distribution. After the larvae have begun to grow conditions have changed within the trees as the result of the combined effects of beetle-fungus attack, and conduction is interfered with. In such instances the solution is apt to be taken up in the inner rings only, and there they are not as effective as when near the surface of the wood.

2. For rustic work, shortleaf pine, red oak, and hickory poles were injected, before felling, with arsenicals. All attacks by insects were unsuccessful after a two months' period with the exception of some ambrosia beetles, and the general results seemed quite promising.

3. For wood preservation purposes, the same chemicals found effective for rustic work were also effective in preventing subsequent insect attack in both barkbeetle-infested and in healthy trees. Also all but one of them were found to be promising fungicides. These results verify those obtained last year.

An examination of the 1930 injected trees revealed that 15 months after treatment most of the chemical treatments were still effective. One of the treated logs that was buried half its length in the ground, was badly damaged by termites in that portion below ground. Some of the other treatments were found to be blue stained, as well as having incipient decay in the outer rings of sapwood. Some of the check logs were found to contain some termite work as well as other insect work, stain and decay.

4. Factors of importance in the absorption and distribution of poisonous solutions in the injected pine trees.

Many factors appear to be involved when one attempts to obtain complete distribution of poisons in a beetle-attacked pine tree. Some of these were mentioned above. One other appears to be of paramount importance, that is, the presence of pitch in the sawkerf of a tree. Apparently, when pitch collects in sufficient quantities as the result of mechanically wounding the tree by making the kerf, absorption and conduction may cease entirely. This was also apparent when the stems of healthy trees were cut off near the ground and immediately stepped into dye solutions. At times when pitch formed and covered the exposed surface the dye only ascended a few inches. Immediately after cutting off a short block the dye was readily absorbed and well distributed.

Two methods were tried to overcome pitching out. They were (1) the addition of a small amount of wood alcohol to the poisonous solution, (2) the making of a sawkerf or cut around the base of the tree a day or two prior to the time of injection, when another cut was made a short distance above the former one for the absorption of the solution.

Results obtained indicate that these methods are an aid to decrease pitching out and also help to increase the rate of absorption.

To determine if the rate of growth and size of the tree would materially affect the rate of absorption and distribution of solutions six large shortleaf pines were selected for the experiment. They were about 70 years old and varied from 10 to 19 inches in diameter breast high, 50 to 70 feet high, and 18 to 30 rings per last half inch. These trees were compared with young second growth trees about 20 years old which were from 5 to 8 inches d.b.h., 25 to 35 feet high, and with 4 to 7 rings per last half inch. Results indicated that, although the rate of absorption was slower, a good distribution was obtained. Similar results were obtained when six large white pines were used, except that the solution was absorbed a little more slowly than in the case of the shortleaf pine trees.

III. A Study of Moisture Requirements of Wood Attractive to Ambrosia Beetles.

A study was begun to determine the moisture content of wood attractive and repellent to ambrosia beetle-attack. A series of tulip poplar trees was used. The work has not progressed far enough as yet to obtain

conclusive results. Several moisture determinations of the wood were made which indicate the following relations:

1. There is a normal moisture gradient from the base of the tree to the top (quite the reverse from pine trees).
2. The center of the stem is more moist at the base than the first 5 and the next 5 rings, but it becomes the driest as it approaches the top of the tree.
3. The first 5 rings are more moist than the next 5.
4. Girdling a tree to the depth of 3 inches was not sufficient to cause the crown to fade or the outer sapwood to dry materially.
5. Felled trees with the branches left on attracted ambrosia beetles after a certain amount of drying had taken place. The attack followed this drying process.

IV. A Comparative Study of Methods Used in Determining the Moisture Content of Wood in Stem Analysis of Trees.

Conflicting opinions exist as to which of several methods is the most accurate in sampling wood to determine its moisture content. A freshly felled log was selected and the following four methods tried: (1) Taking borings by a Pressler borer; (2) with an inch auger; (3) a block section, and (4) a cross-section of the stem.

Although enough data were not secured to make the results as conclusive as was desired, it appeared that the increment boring, although a little lower in value than the cross-section, could be expected to give quite satisfactory results and be a fair indicator of the moisture content of the tree. This is of value in following seasonal variations in moisture content of trees.

V. Spraying Experiments to Control the Southern Pine Beetle Under Shade Tree Conditions.

Toward the end of the field season there was an opportunity to start work to try to develop a method to save shade trees from beetle attack. There was time for only a limited amount of work and not time to determine the ultimate effect of poisons sprayed upon infested trees. Therefore, no conclusions are available as yet. However, it is significant that the trees so treated did not die quickly, as did the untreated ones, and when last observed in March, 1932, six months after treatment, they were still living.

VI. Physiological Studies

Caird continued his studies concerning the physiology of trees attacked by barkbeetles and their associated fungi. Considerable valuable

data were secured in an endeavor to isolate the various factors concerned in attempting to determine (1) what agency kills the tree, and (2) how it does it. Since this is the subject of a separate report it will not be mentioned further here.

VII. Locust Borer Studies

Final observations were made in the locust plantations used in spraying experiments for the control of the borer. The chemicals used effectively controlled the borers and at the time did not cause any injury to the trees.

Tentative plans for 1932

The experimental studies contemplated for 1932 are mainly a continuation of those undertaken during the past year. They are as follows:

I. Tree Injection Work: (1) For wood preservation purposes, (2) for rustic work, and (3) for brood control of barkbeetles.

II. Spraying experiments: to determine further the possibilities of controlling the southern pine beetle under shade tree conditions.

III. Biological Studies: (1) To determine the importance of the activities of woodpeckers in the natural control of the southern pine beetle, (2) to note the effect of the habit of the beetles in re-emerging after initial attack in causing an increase in beetle population, and (3) to determine the minimum concentration of beetles necessary for successful attack.

IV. Forest Drain Studies: To establish permanent sample plots in the mountainous piedmont and coastal plains regions to determine the depletion caused by the southern pine beetle to pine stands.

V. Physiological Studies of beetle-fungus attacked trees: to determine more exactly the factors responsible for the sudden death of the trees and the way in which it is accomplished.

VI. Forest Nursery Studies: To determine possibilities of controlling May beetle larvae which cause extensive injury to coniferous seedlings.

EXPERIMENTAL FORESTS

Bent Creek Forest

Substantial progress was made in 1931 in the plans for the intensive development of Bent Creek Experimental Forest as an investigative center. This forest consists of about 1100 acres in the lower Bent Creek valley in Pisgah National Forest, ten miles from Asheville, T. C. It was reserved for investigative purposes in 1925 and 1926, surveyed, mapped, cruised and divided into 21 permanently marked compartments. Work in silviculture, forest entomology, and forest pathology has been conducted there since 1925. The past year saw the beginning of a plan of silvicultural operations on a larger scale than the small sample plots previously used. These operations, which in 1931 covered about 40 acres, have already been described under "Management: Mountain Forest."

The increasing activities at Bent Creek called for more nearly adequate accommodations than were supplied by the small laboratory building, garage, and insectary built in 1925. An opportunity for additional improvement was afforded by funds received early in 1931 for relief of unemployment. Three small field laboratories, a green house, a bunk and mess hall, and a ranger's dwelling were built, and water, electric, and telephone connections made with the city of Asheville. These buildings afford living and working quarters for field parties of four bureaus of the Department of Agriculture - Forest Service, Entomology, Plant Industry, and Biological Survey - now engaged in studies at Bent Creek. A four-mile road bisecting the forest and making all parts of it easily accessible was also built.

Protection of experiments and improvements was provided in August through the appointment of Mr. E. M. Manchester as resident ranger. Mr. Manchester will also participate in the investigative work. Plans for budgeting the expenditures on the forest have been prepared.

Proposed experimental forest on the Monongahela National Forest

During September, 1931, Barrett and Sins made a trip through the Monongahela National Forest for the purpose of taking further notes on possible locations for an experimental forest. Four areas were visited; three in the Cheat River and one in the Greenbrier ranger district. A memorandum prepared as the result of this examination indicates that an area on Elk Lick Run, where the Station has done some work in the past, offers the most advantages for an experimental area on which to study the handling of hardwoods. A further inspection of this area will be made in the spring of 1932 by representatives of the Station and the administrative branch of the Forest Service. If the area is approved by them, a preliminary survey will be made as the basis for recommendation that the area be reserved and developed as an experimental forest.

NATURAL AREAS

To preserve in unmodified condition a forest area representative of the virgin growth of red spruce, balsam fir, and northern hardwoods, a reconnaissance was made by Frothingham and Supervisor Mattoon, of the Pisgah National Forest, of the spruce belt on the east slope of the Black Mountains, N. C. This range contains the highest peaks east of the Mississippi River and is in view of much-traveled highways, presenting an outstanding mountain mass of much scenic beauty and interest. The purpose of the reservation of this area from cutting was to perpetuate this forest type, with its plant and animal life and soil conditions, for purposes of science and education. It is quite probable that similar stands of spruce and balsam on Grandfather Mountain and elsewhere in western North Carolina, except in the Smoky Mountains National Park, will eventually be cut off to assist in liquidating the heavy investments tied up in timberlands. The area examined is entirely on the Pisgah National Forest.

This preliminary reconnaissance was reported to the Washington Office and it was decided to reduce the total area of 2950 acres, which it had been proposed to include, to the area within a single creek drainage. It is accordingly proposed that during the coming spring representatives of the Pisgah National Forest and the Appalachian Station will survey the drainage of Middle Creek and prepare the usual formal report requisite for the designation of this area as a natural area.

Three other smaller areas on the Pisgah National Forest are now under consideration for similar reservation. These are located on Singe Cat Creek, Neal's Creek, and Big Ivy. The two latter cover areas of only about 300 to 400 acres, and the first-named is even smaller than this, containing a group of unusually fine old-growth hardwood trees.

It is proposed during the spring that a representative of the Station will join R. M. Evans of the Regional Office in a reconnaissance of Ramsey's Draft on the Shenandoah National Forest and of two spruce areas on the Monongahela National Forest with reference to their reservation as natural areas.

ALL-SERVICE PROJECTS

Private forestry (M-I, W. O.)

No work was done on this project by the Station in 1931. No examples of private forestry practice were met with in the Southern Appalachian region additional to those already recorded.

Regional growth (ME-1, W. O.)

The work now carried under the heading Extensive Revision would probably come under this project. It has been discussed elsewhere in this report.

Growth data from a few sample plots measured in north Georgia will contribute to the knowledge of growth in this region. These plots are mentioned under the subject Mensuration.

Converting factors (ME-2, W. O.)

Work has been started in north Georgia to obtain a relation between cubic foot and cord contents of hardwood trees representative of the lower mountain woods. The figures are to be used specifically for converting a cubic foot into a cordwood volume table.

Manual of research methods (ME-3, W. O.)

A revised draft of the manuscript for the sample plot section of the Manual of Research Methods was prepared by Buell from comments sent in by the various experiment stations.

FINANCES

The relative importance of the projects carried by the Station is indicated in the budget (Form 1) for the fiscal year 1933 (beginning July 1, 1932), which is attached to this report.

The Station's total resources for the next fiscal year, as reduced by budget cuts, will be \$50,320, of which \$44,520 is for projects under the heading of Forest Management Investigations and \$5800 is for studies of Erosion and Streamflow under the heading of Forest Influences.

MEETINGS

The two meetings of outstanding importance during the year were those of the American Forestry Association, held at Asheville, June 3-5, and of the Appalachian Forest Research Council on June 2, also at Asheville.

The Council meeting was attended by twelve Council members and fifty-one guests. The first part of the program was a review of the year's progress and future plans for the Station's major investigative projects presented by the men in charge. The program also included the following addresses:

Pending research on forest fire weather by the U. S. Weather Bureau - - E. B. Calvert, Chief of the Forecasting Division, U. S. Weather Bureau.

Streamflow and erosion - - H. H. Bennett, in charge soil erosion investigations, Bureau of Chemistry and Soils, and E. D. Burchard, U. S. Geological Survey.

Research and the administration of Southern Appalachian national forests - - J. C. Kircher, Regional Forester, Region 7.

Status of land acquisition for the Smoky Mountain National Park - - Verne Rhodes, Secretary, North Carolina Park Commission.

Forest Biology - - W. B. Bell and Lisle Morrison, U. S. Biological Survey.

The Dutch elm disease - - R. W. Leiby, North Carolina State Entomologist.

Forestry at Duke University - - C. F. Korstian, Director of Duke Forest.

Forest investigations by State Foresters - - H. S. Newins (West Virginia), J. S. Holmes (North Carolina), B. M. Lufburrow (Georgia), T. A. Smith (South Carolina), and J. O. Hazard, (Tennessee).

Eight resolutions were passed relating to the work of the Station.

For the American Forestry Association meeting the Station prepared an exhibit, one feature of which was a series of forest litter samples taken from stands in the Bent Creek Forest. This showed the beneficial effect of a mixture of hardwoods in pine stands and the steps in the deterioration of the litter under a pine-oak stand subjected to burning. A map of the Station territory showing all points where work is being done, sections from a fast growing yellow poplar, and from fire damaged oaks; and a set-up for injecting pines with poison solution to kill den-droctonus beetles were also on display. Members of the staff led a field trip through the Biltmore Estate and accompanied members of the Association on other excursions through the forest about Asheville.

In April the senior forestry classes of the University of Michigan and the North Carolina State College visited the Station under the leadership of Professors L. J. Young and R. W. Hayes, respectively. In June a three-day field trip of forest school professors was held on the Pisgah National Forest at the invitation of Region 7.

PERSONNEL CHANGES

The Station staff was increased in August, 1931, by the appointment of R. M. Nelson as silviculturist, and E. H. Manchester as ranger in charge of buildings and grounds on the Bent Creek experimental forest, and of Mrs. Mary P. Gidger as junior stenographer. Dr. Nelson, who was formerly assistant pathologist at the Station, will be engaged in the study of forest fire damage. Mr. Manchester was formerly senior ranger on the Pisgah National Forest. In his new capacity he will assist in various projects under way at Bent Creek.

INVESTIGATIVE NEEDS

The outstanding needs for research in this region, which have not yet been adequately met, are as follows: Because of their urgency they stand in the first line for consideration.

Forest Survey: One of these needs is for an extension to this region of the forest survey now in operation in the Pacific Northwest, the southern pine and hardwood region, and elsewhere. There is no specific and reliable information as to the areas of the different classes of timberland in the Southern Appalachian region; the kind, quantity, and quality of the timber; the rate at which it is being cut; and other related subjects. Such information is indispensable for all forestry activities. It is essential for sound regional and state policies of timberland management. Whether viewed from the standpoint of timber production, watershed protection, or the economics of manufacture, the information that such a survey would supply is fundamental. A movement to bring about a survey of timberland resources would unquestionably receive the support of lumbermen, industrial and other organizations in contact with timber problems in the Southern Appalachians. It would greatly benefit all forestry enterprises.

Streamflow and erosion studies: For several years past the Station's annual reports have stressed the need for a comprehensive study of forests in relation to streamflow and erosion. The Appalachian Forest Research Council has recommended that an annual appropriation of \$30,000 be provided for this purpose. For the fiscal year beginning July 1, 1931, the Station was given the sum of \$6,000 to begin the study which was discussed earlier in this report. While it is very gratifying that some work on this important project can now be undertaken, the amount provided is altogether inadequate except for preliminary studies on a small scale.

The importance of controlling flood waters, reducing erosion, and retarding the rate of sedimentation in collecting basins and reservoirs, unquestionably justify the allotment of enough funds to establish the effects of different kinds of watershed cover in restraining run-off and sedimentation. The Station believes that if properly carried out on a scale commensurate with their importance, such studies will require an annual allotment of at least \$40,000.

Growth studies: This is one of the most important of all the subjects that are in need of investigation, but as yet the Station has received no allotment for it. An accurate knowledge of growth is a fundamental necessity in timberland management; its absence at best gives uncertainty, and in the majority of cases would result in poor financial control, if not failure of attempts at commercial timber growing. The subject is regarded as of major importance in the investigative program. Regardless of the lack of funds for the study of growth, it has been necessary for the Station to carry on a small amount of it and this has been done incidentally, under allotments for other projects. The inadequate results point only to the need of providing a special fund for the work ample to carry it on as a major project. An amount of \$15,000 or \$20,000 is needed for it.

Planting studies: This subject also has been on a "shoestring" basis. The only work so far done has consisted of about 15 acres of small test plantings at two points near Asheville, N. C. Questions of raising nursery stock from seed, transplanting and field planting methods, the adaptability of different species and climatic strains to local soils and climates, and related subjects have so far remained untouched by the Station. There is a particularly urgent need at present for forest planting in the rehabilitation of forest lands in all parts of the Station's territory, and they should be provided for in the Station's program by funds estimated at \$10,000 or \$12,000.

Forest management studies on the piedmont and other plateaus: As stated at the beginning of this report, no funds have yet been given the Station for carrying its investigations to the piedmont and other plateaus, which comprise over half the Station's territory. The small farm woodlands of the plateaus aggregate over 20,000,000 acres. Their location near markets gives them unusual advantages for management. The regional consumption of wood products is centered largely on the plateaus, where wood-using industries are numerous and varied. This gives importance to the provision of continuous local supplies. The possibility of making sub-marginal agricultural lands profitable by furnishing such supplies ties in with the large and urgent problem of land use which is now being widely discussed. Farm woods offer a means for increasing the farm income which has quite generally been neglected through ignorance of the productive capacity of forests and of methods for increasing the quantity, quality, and continuity of the output. The Station therefore believes that investigations should be extended to the agricultural plateaus, and that funds of \$15,000 or \$20,000 should be provided for the purpose as soon as conditions improve sufficiently to permit it.

Forest economics: This is a subject which has had to be almost entirely excluded in favor of the silvicultural studies authorized for the Station. It is extremely important for the development of Southern Appalachian timberlands that the economic feasibility of their management be worked out. The McSweeney-McNary Act makes funds available for such work as for the other lines of investigations mentioned in this section of the annual report. Studies of the financial aspects of timber growing, generally similar to that now under way at the Southern Station, would be of

great benefit in the Appalachian region, and would round out the present program of the Appalachian Station. Such a study ought to command the services of at least two technically trained men, and an allotment of \$10,000 for their salaries and expenses. It is to be hoped that such an allotment will be granted as soon as the present financial stringency is lessened.

Investigations in forest pathology: The transfer of R. M. Nelson from the Bureau of Plant Industry to the regular staff of the Appalachian Station caused a suspension of the work in forest pathology. The appointment of a successor to Dr. Nelson was impossible under limitations of expenditures set up during the present emergency. Very effective work has been accomplished so far, as summarized by Dr. Nelson elsewhere in this report. The need for the continuation of pathological investigations is urgent and they should be restored and increased at the earliest possible date.

Biological investigations: Work in game management and the relation of animals to the silvicultural processes of the forest is to be classed as of first importance among the studies directed toward the complete economic development of the Southern Appalachian timberlands. The greatest need in these studies at the present time is for the development of food habits research, which as stated in Mr. Burleigh's discussion elsewhere in this report, lies at the root of several major investigations under this head. This was fully recognized by the Biological Survey, which proposed to place an investigator of food habits at the Appalachian Station last year. These plans have had to be deferred but it is most important that such a man be attached to the Station as soon as it can be done.

Forest fire weather research: The United States Weather Bureau is to begin about March 1, 1932, investigations as to the technique of forecasting fire weather in the Southern Appalachian region. This subject is one which ties in so closely with the policies of forest protection now followed by the state forestry departments in cooperation with the United States Forest Service, that urgent requests for research by the Weather Bureau, leading to the development of a satisfactory fire weather warning service, have been recieved from the state foresters and others who recognize the menace of forest fires and the urgency of utilizing all means to protect the forest. The Station welcomes this new cooperation and proposes to assist to the extent that its present program of forest fire damage investigations will permit. It is probable that somewhere in the forest fire weather research the factors affecting the inflammability of forest fuels, such as leaves and litter, will become of great importance. It is foreseen that this study can be made extremely valuable and funds for its continuation by the Weather Bureau and also to the extent necessary by the Appalachian Station, should be granted.

In this connection it is worthy of note that very important work in the fire damage investigations had to be omitted by the Station because of lack of funds and the estimates of field expenses for only the urgent phases of the work during the next fiscal year had to be scaled down.

36 per cent. With this reduction it is obvious that the Station will not be able to handle any large amount of cooperative work under this very important subject.

General investigations by the Station: With an allotment of only about \$51,000 after ten years of existence, the Station's present program, which contains relatively few subjects, is being carried with funds which cramp the work on all the major projects. For example, it is possible to spare only the time of one man for coastal plain activities, and even there the demands of the mountain work have made it necessary to cut the coastal plain work still farther. It is recognized that forest production on the coastal plain is exceedingly important, bearing a very practical relation to large interests in the manufacture of forest products of many kinds. In the mountains the Station, in spite of the fact that it is concentrating its work in this section, has been able under its present resources to work on a scale which lacks the efficiency that a relatively small increase would permit. This is true of the studies in management, protection, mensuration, and planting. For the development of the coastal plain and mountain work alike, additional funds are badly needed.

SUMMARY OF FOREST SERVICE PROJECTS, AND ASSIGNMENT OF PERSONNEL

Forest management investigations

M-1 Management: mountain hardwood forests.

E. E. Frothingham, L. I. Barrett, J. H. Buell,

A. L. MacKinney, C. A. Abell, and M. S. Abell.

M-3 Management: coastal pine forests.

A. L. MacKinney

Pf-3 Protection: fire damage.

R. M. Nelson and I. H. Sims (Mountain region),

A. L. MacKinney (Coastal plain).

ME-1 Mensuration: mountain hardwood forests.

L. I. Barrett

Fp Forestation: planting.

I. H. Sims and L. I. Barrett

Bp Botanical studies: phenology.

J. H. Buell and M. S. Abell

Forest influences

I-1 Streamflow and erosion

C. R. Hursh

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" 27 - The Carolina junco
October 4 - The brown creeper
" 11 - The winter wren
" 18 - The black capped chickadee
" 25 - The mountain vireo
November 1 - Hawks and owls of the Great Smokies
" 15 - The warblers
" 29 - The golden-crowned kinglet
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2. Humus types produced by fire and cutting.
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